p. 280. **Hydralector.**

Metopidius Wagl. Isis, 1832, p. 279, included *Parra africana* Lath. and *P. œnea*, Cuv.

Hydralector Wagen, Isis, 1832, p. 280, included *Parra cristata* Vieill. and *P. gallinacea*, Temm.

In 1840 Gray indicated *P. œnea* Cuv. as the type of *Metopidius*. *P. œnea* (Cuv. 1817) = *P. cristata* (Vieill. 1817) = *P. indicus* (Lath. 1790). His assignment of a synonym of *P. œnea* as the type of *Hydralector* was, of course, a mistake and must be disregarded. The species *P. cristata* Vieill. thus disappears from the genus *Hydralector*, leaving *P. gallinacea* Temm. as the type. Mr. Mathews's name *Irediparra* is a mere synonym of *Hydralector*.

Sharpe subsequently proposed *Phyllopezus* [Cat. Birds B.M. xxiv. p. 76 (1896)] as a new generic name for *P. africana*.

The number of genera made for the Jacanas might probably be reduced with advantage.

p. 301. **Carpophaga.**

Carpophaga Billberg, Synopsis, Faun. Scand. i. pt. 2, Table A (1828), is a name proposed for the genus of Cuckoos known as *Phœnicophæus* Vieill. I have not considered it necessary to support this change, which has not been accepted except by one or two persons.

XV.—*Studies on the Charadriiformes.*—IV. *An Additional Note on the Sheath-bills: Some Points in the Osteology of the Skull of an Embryo of* Chionarchus "minor" *from Kerguelen.*—V. *Some Notes on the Crab-Plover* (Dromas ardeola *Paykull*). By Percy R. Lowe, M.B., M.B.O.U.

(Text-figures 7–11.)

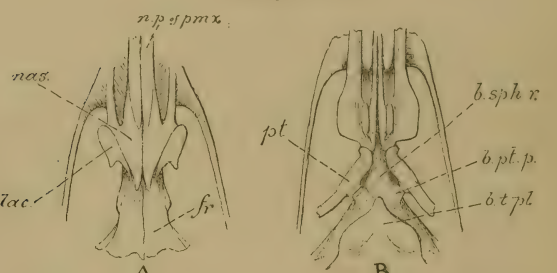
IV. The Skull of an Embryo of *Chionarchus "minor."*

During the preparation of my paper on the Sheath-bills, published in the January number of 'The Ibis' for 1916 (pp. 122–155), I had unfortunately no time to make a

dissection of one of the embryos of *Chionarchus* taken on Kerguelen during the voyage of the 'Challenger' in 1874. I have since been able to do this, and the results as regards two points, at least, in regard to the osteology of the skull seem to be sufficiently interesting as to be worthy of record.

The exact age of the embryo selected is, of course, impossible to determine; but, as far as I could judge, it was not much more than half-developed towards the point of hatching. At any rate, it was considerably smaller than other embryos taken from the egg.

Text-figure 7.



Portion of the skull of an embryo *Chionarchus* "*minor*" from Kerguelen.
A. From above. B. From below.

fr., frontals; *lac.*, lacrymals; *nas.*, nasals; *n.p. of pmx.*, nasal process of premaxillæ; *b.sph.r.*, basisphenoidal rostrum; *b.t.pl.*, basi-temporal plate.

(1) After a little careful dissection, the quadrates, pterygoids, and palatine plates were exposed, and the first, and probably the most interesting, point to be discovered was that, *contrary to what obtains in the adult bird*, a very distinct and obvious basipterygoid process was demonstrated, projecting from either side of the basisphenoidal rostrum. The distal extremities of these two processes were apparently coated with a cartilaginous articular surface, while, corresponding with these two articular surfaces, two very distinct

facets were found seated on the processes from the pterygoids. Both processes from the basisphenoidal rostrum were in contact with the facets on the pterygoids, and in every respect these basipterygoid articulations seemed to be as perfect and complete as in any adult Plover (such as the Golden Plover), in which these articulations persist throughout maturity. It may here be noted that in the Oyster-catchers these basipterygoid articulations persist throughout adult life; and this fact, along with others, seems to point to the conclusion that, although the Oyster-catchers are in some respects highly specialised, they are not so fundamentally specialised away from the true Plovers (Charadriidæ) as some of the more aberrant Plovers, such as the Sheath-bills, Crab-Plovers, Pratincoles, Skuas, Gulls, and Terns. In ordinary words, they do not appear to have extricated themselves from the true Plover group to the same extent as the aberrant types just enumerated, and, so far as one can as yet form an opinion, they must be looked upon as "true Plovers" and classified with the true Limicolæ (Charadriidæ + Scolopacidæ). An alternative view is to regard them as standing at some point between the true Limicolæ and the Laro-Limicolæ (Sheath-bills, Crab-Plovers, Pratincoles, Skuas, Gulls, Terns, &c.), but very much nearer the former than the latter. The Oyster-catchers, indeed, seem to stand in about the same relation to the true Plovers (Charadriidæ) as the much-specialised Woodcocks do to such a generalised scolopacine type as the Chatham Island Snipe (*cf.* 'Ibis,' Oct. 1915, pp. 690–716).

(2) In the embryo Sheath-bill (*Chionarchus*) the morphology of the lacrymal and frontal region was found to be both interesting and instructive. Unlike what obtains in the adult Sheath-bill (*cf.* 'Ibis,' 1916, p. 144, and text-figure 3), the superior or orbital portion of the lacrymal in the embryo has the form of a thin lingulate plate of cartilage, which has a free and independent existence laterad of the nasals, and there is not the slightest hint at fusion between the two bones (*cf.* text-figure 7 A).

In the adult Sheath-bill the identity of the lacrymal of

either side is completely lost in the shield-like bony overgrowth which covers the proximal extremities of the nasals (Ibis, 1916, text-figure 3). In the embryo, on the contrary, we get no hint of this shield-like arrangement, nor of the spongy osseous tissue which, as a fact, we know will later on spread inwards to fuse in the middle line with a similar bony growth derived from the other side.

We thus find that the morphological picture presented by the lacrymo-nasal region in the embryo Sheath-bill reflects some primitive generalised or ancestral type, from which we could well imagine that the distinctive form and shape of the lacrymo-nasal region proper to the adult Oyster-catcher, Sheath-bill, Crab-Plover, Skua, or Gull might easily have been evolved.

(3) *Supraorbital Region.*—As regards its more generalised and more simple structure, all that has just been noted in regard to the facial region applies equally to the whole supraorbital region. It presents a generalised condition from which any of the peculiarities proper to the aberrant "Plover" forms just enumerated might well be elaborated. In some respects, it is not very unlike the condition found in *Squatarola*. The "notch," for instance, just caudad of the lacrymals was not much more evident than it is in that genus. In the adult Sheath-bill this notch is conspicuous. It may or may not be connected by a bridge of bone so as to form a fenestrum (*cf.* 'Ibis,' 1916, p. 142), and the fact that it is only just indicated in the embryo is what might have been expected.

As regards the supraorbital gland, this is situated along quite the outer fringe of the supraorbital margin, and there is no very obvious groove corresponding to it. It would appear, therefore, that as the gland increases in size with maturity, so the supraorbital grooves grow deeper, wider, and more defined; and this, again, goes to suggest that these grooves, which are so conspicuous in the adult Sheath-bill and the aberrant Plovers already referred to, have but very little significance from the point of view of phylogeny. The gland apparently has grown to such large proportions in

the adult because the birds possessing it are exposed to the same influence of salt water to a greater degree than the generality of Waders.

When going through the osteology of the Ducks, I noted the fact that most, if not all, sea Ducks had large supra-orbital depressions and consequently large supraorbital glands. In fresh-water Ducks the grooves were quite inconspicuous. Subsequently I found that Mr. Pycraft had noted the same interesting fact. It seems reasonable to conclude that the internal secretion of these glands may counteract in some way the adverse effect which salt water might have on the bird's plumage.

(4) In the adult Sheath-bill the antorbital plates are non-existent, or, at least, only the smallest relic of them ossifies and remains evident. In the embryo they are represented by a quadrangular plate of cartilage, which, in form and shape, as well as in its relations to the descending process of the lacrymal, is quite characteristically pluvialine.

The manner in which the descending process of the lacrymal joins the antorbital plate in the embryo is also quite pluvialine.

Summary.—All these points, in as far as they go, confirm the belief assumed in my paper on the Sheath-bills that these birds are pluvialine.

V. Some Notes on the Crab-Plover (*Dromas ardeola* Paykull).

Dromas is such a peculiar and aberrant Charadriiform type that any fresh crumbs of knowledge that can be gleaned about it seem worth noting. If there is anything in this paper worth recording, it is entirely due to the trouble which Dr. Drake Brockman took in procuring for me, through Mr. Bethel, an adult bird and two nestlings from the Somaliland Protectorate. These were preserved in spirit, and arrived in England in excellent condition. Although the process *

* A small hole is punctured exactly in the mid-line of the abdomen; the birds are immersed in spirit for one or two days, then taken out and wrapped in rags soaked in spirit, and then packed in a biscuit-tin, the lid of which is soldered down.

of forwarding specimens of this nature is in reality comparatively simple, one is anxious to make full acknowledgment of the trouble taken by Dr. Brockman and Mr. Bethel, and all the more so that one fully realises the difficulty there usually is in getting little jobs of this description undertaken, whereby many of the minutiæ of scientific investigation are disappointingly held up. In this connection, I was very anxious to ascertain if, in the chick of *Dromas*, the basipterygoid processes and their corresponding facets on the pterygoids would be evident, although there is no trace of them in the adult. Investigation proved beyond doubt that they are present (see below under "Skull of Chick," p. 335); but had it not been for the trouble taken by Dr. Brockman, this small, though highly interesting, addition to the sum of our knowledge of evolution might still have long remained a secret.

Geographical Distribution.—In the 'Catalogue of Birds of the British Museum,' vol. xxiv. p. 29, the distribution of the Crab-Plover is thus stated: "Shores of Eastern Africa and Madagascar, north to the Red Sea and Arabia, thence east along shores of the Indian Ocean to South India and Ceylon, as well as the Andaman and Nicobar Islands"; to this statement I have nothing to add.

Life-History.—As the complete record of the Crab-Plover's life-history, as far as it is known, is scattered among many communications upon the subject, it may be worth while to reproduce here a short *résumé* of its habits. The Crab-Plover seems to be a purely littoral species, and throughout its range is only very locally migratory. It appears to be only met with where the shores are sandy, or where arid stretches of wind-blown sand or of coral and shell-débris form a somewhat cheerless fringe to the ocean. Along such sun-baked stretches of sandy littoral the Crab-Plover is met with in small flocks of about eight to ten birds. It lives upon molluscs and crustaceans, its large and compressed cone-like bill forming a trenchant weapon with which to deal with this sort of prey. The Crab-Plover can run quickly, and, curiously enough, its flight reminded

Captain Butler ('Stray Feathers,' vol. v. 1877, pp. 212, 232) of that of the Jacana (*Metopidius*). Jacanas, as known to me (*Parra*), fly moderately fast and usually fairly close to the water or marsh over which they are passing. The flight is straight and deliberate, the legs are trailed out behind after the manner of Stilts, and the wings are beaten rapidly or at times held motionless, so that the bird glides on for a space. In a word, the flight of *Parra*—and I have seen scores of these birds flying—is very far from being typical of a normal Plover. The Crab-Plover is said to be a restive bird, with a raucous cry somewhat like that of a Crow. As is well known, the Crab-Plover lays but one egg, which is both large and white, with no markings. This egg is deposited at the end of a narrow tunnel in the side of a sloping sand-bank, sand-dune, or deposit of coral or shell-débris. No attempt at a nest is made. The burrow is about four feet long, and is curved either to the right or left in a bow-shaped fashion. The passage is narrow, and about a foot beneath the surface, while the entrance to it is usually near or under a tussock of grass or some shrubby plant. Baron von Heuglin (Orn. Nordost-Afrika, p. 1045) raised the question whether the Crab-Plover actually makes this burrow itself or occupies one previously excavated by a sand-crab. He says that in the flat and lonely coral islets of the Red Sea, where Crab-Plovers breed, great numbers of crabs of various species live in holes tunnelled obliquely through the thick layers of sand and shelly débris. The burrows occupied by the Crab-Plover are precisely similar, and he says: "Whether they excavate them themselves or take possession of crab-holes I cannot positively say, but, in view of their very small diameter, we may assume that they were originally crab-burrows."

Hume ('Nests and Eggs of Indian Birds'), referring to the breeding-habits of this Plover, says: "It would seem that the Crab-Plover begins to lay at the end of April or very early in May, and that by the middle of July the young have not yet permanently left the nest-holes, but are still found in these during, at any rate, the daytime. Whether

they (the young) come out to feed is still doubtful." Dr. Brockman informs me (*in litt.*) that he knows that the birds in Somaliland breed in May and June, and that the specimens of the young chicks sent to me must have been taken at the end of June or early in July. Hume (*l. c.*) goes on to say that the young "seem to be able to run well within ten days of hatching," so that the question arises, why should the young remain so long in the burrow? Von Heuglin says that they do not leave the nest for a long time, although they are well able to run. He also says that they were obviously blinded by the light, "cheeped" like young chickens, and would run as fast as possible to any broken rocks or fragments of stone to take refuge in the shade. Von Heuglin also expressly states that on the Red Sea islets marauding enemies practically do not exist, but he, curiously enough, overlooked the land-crabs. In tropical latitudes, land-crabs wage a murderous warfare on the young of Terns, Gulls, and Waders, and it appears to me highly probable that this enforced sojourn in the burrow on the part of the young, or, indeed, the laying of the egg at all in such a burrow, may have been induced by the danger from the multitudes of these rapacious crustaceans. It may be asked, what is to prevent a land-crab crawling into the burrow after the young? To this I think the answer is, the adult bird, with its trenchant bill, is on guard outside.

Description of Nestling (a few days old).

Above. Down over occipital region, back of neck, mantle, and wings smoky grey, considerably darker over rump. Over the vertex and in the loral, auricular, and circumorbital regions it is dark sooty grey.

Below. The chin and forneck are dirty white, breast and abdomen white. Across the lower part of the neck, or the upper pectoral region, there is a faint indication of a dark band caused by the filiform endings of the downy feathers being of a dark sooty-grey coloration.

Bill. Mandibles dark horn-colour, nearly black. Gape extending backwards to a spot immediately below the inner

canthus of the eye. General shape of bill unlike that of adult—more typically pluvialine. Inside of mouth pale yellow; tongue without spots or markings.

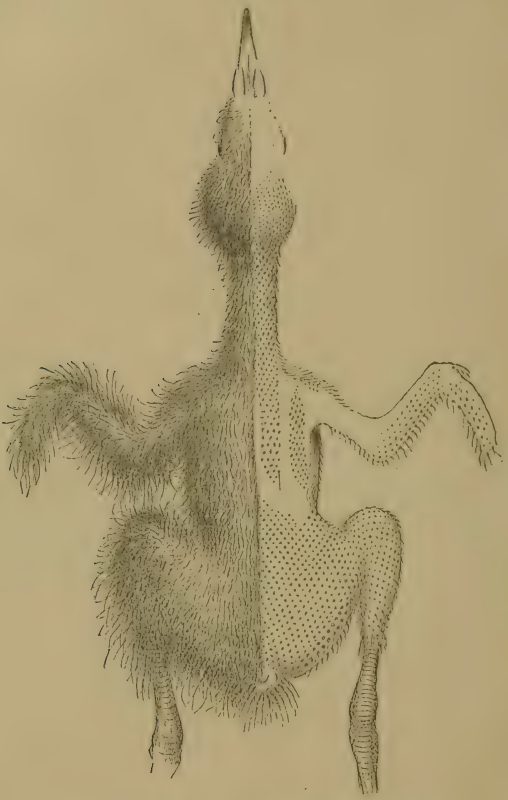
Feet and legs. Slaty blue; scaling of podotheca exactly similar to that of the adult; webbing as in the adult.

Pterylosis.

The accompanying drawing (text-figure 8) depicts the feather-tracts of a young Crab-Plover a few days old, as viewed from the dorsal aspect. Beyond calling attention to the strength of the crural tract, which is sufficiently obvious in the figure, a detailed description seems unnecessary.

A drawing which I made of the feather-tracts of the adult Crab-Plover, so kindly sent to me by Dr. Brockman, is practically identical in detail with the figure of the young Crab-Plover here reproduced, but the feathers of the anterior dorsal tract are degenerate from the vertex of the skull backwards to a point about an inch distad of the bifurcation of the tract in the interscapular region. From this point to the termination of each bifurcation the spinal tract is very strong. The crural tract in the adult is also conspicuously strong and in marked contrast to the degenerate feathers of the posterior portion of the dorsal tract. This posterior portion of the dorsal tract, or to give it the name which I employed in the description of the pterylosis of the embryo Sheath-bill (*cf.* 'Ibis,' Jan. 1916, p. 130)—the dorsi-sacral tract,—is separated from the anterior portion by a distinct break in the feathering of both the young and adult bird (*cf.* text-figure 8), and its anterior extremity is not bifurcated, not even narrowly, as it is in the case of the Sheath-bill (*cf.* 'Ibis,' 1916, p. 131, text-figure 1). In an adult specimen of *Larus argentatus*, whose feather-tracts I have carefully examined and drawn, this posterior portion of the spinal tract (dorsi-sacral) is very deeply and conspicuously cleft. The same condition of things obtained in some young chicks of the Common Tern which I examined. Moreover, in these young Terns the dorsi-sacral tract was quite strong

Text-figure 8.



Dorsal view of a young Crab-Plover to show the feather-tracts.

and ran into the anterior (bifurcated) portion of the spinal tract so as to be almost continuous with it on each side of the mid-line. As far, then, as can be deduced from a comparative study of the pterylosis of the Crab-Plover, in either the chick or the adult, this peculiar Wader appears to have no close relationship to either the Gulls or Terns. Unfortunately I have been unable to compare the feather-tracts of *Dromas* with those of *Recurvirostra, Himantopus, Hæmatopus, Œdicnemus*, or *Stercorarius*. A study of the pterylosis of the young chick or embryo in any or all of these forms could hardly fail to be of interest. One thing, however, may be stated here with some assurance, viz. that a study of the pterylosis of the Crab-Plover proves that this form is sharply differentiated from the Charadriidæ or the Scolopacidæ.

Osteology.

So far as I have been able to ascertain, we are indebted to J. Van der Hoeven, a Dutch Naturalist, for the only formal paper on the osteology of *Dromas* which is available (Arch. Néerl. des Sci. Exactes et Natur. 1868, tom. iii.–iv. pp. 281–295). In this paper the author expressed his belief that *Dromas* had affinities with *Œdicnemus*; but, strangely enough, he says, in the same paper, that, of all the skulls of birds which he had examined, he found none with more agreement with the skull of *Dromas* than that of *Hæmatopus*; and he thought that these two genera came very close to one another.

Van der Hoeven, in the same paper, quotes Blyth as having expressed the opinion that *Dromas* was allied to the Terns (*cf.* 'Prodromus Faunæ Zeylanicæ,' by E. F. Kelaart, Colombo, 1852, 8vo; Appendix, pp. 45, 46). Apparently Blyth chiefly formed his opinion on the shape of the bill in the adult and the plumage of the young; but, whatever factors influenced him, he seems to have been as near (or possibly nearer) the truth as Van der Hoeven. In the 'Hand-list of Birds,' vol. i., Sharpe placed *Dromas* in his

suborder Cursorii. In his Address to the International Ornithological Congress ("The Classification of Birds") *Dromas* is included in a distinct suborder, Dromades, of the order Charadriiformes.

The following notes may possibly be the means of throwing additional light on the interesting problem of the affinities of this unique Wader. They are offered more because of the somewhat general nature of Van der Hoeven's remarks than from any belief that the actual secret of the evolution of this form will be more than touched.

The Skull of the Adult.

Occipital Region.—The occipital condyle forms less than a hemisphere and is sessile. The foramen magnum is longer in the antero-posterior diameter than from side to side. In *Hæmatopus* the foramen magnum is rounder, the lateral diameter in some skulls even exceeding the antero-posterior. In the Œdicnemidæ this foramen is likewise rounder, but the genera vary somewhat in regard to its shape. In *Chionis*, *Larus*, and *Stercorarius* the foramen is not so elongated as in *Dromas*.

Text-figure 9.

Skull of *Dromas* viewed from behind. *tf.*, temporal fossa.

The plane of the foramen magnum in *Dromas* is nearly parallel with the long axis of the skull. Thus the foramen looks nearly directly downwards. In *Hæmatopus* it also looks directly downwards. In the Gulls, Skuas, Sheath-bills, and Stone-Curlews the plane of the foramen is inclined at

various well-marked angles with the plane of the long axis of the skull.

The plane of the whole occipital area in the Gulls, Skuas, and Sheath-bills makes a much smaller angle with the long axis of the skull than it does in *Dromas*. Thus in the Gulls the occipital area looks almost directly backwards. In *Dromas, Charadrius*, and *Squatarola* it looks nearly directly downwards.

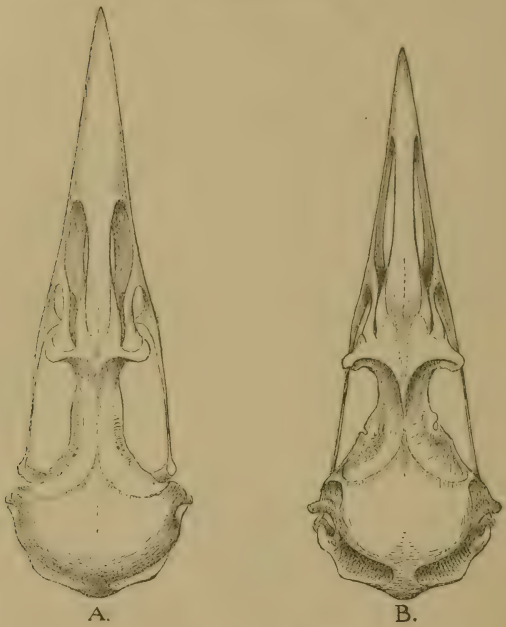
Lambdoidal Ridge.—In *Dromas*, as also in *Larus*, the outer extremity of this ridge bifurcates into two strongly marked divisions, one proceeding forwards to become merged in the squamosal, the other downwards to form the outer border of the paroccipital process. In *Hæmatopus*, *Œdicnemus*, and *Stercorarius* the condition is more pluvialine—that is to say, the lambdoidal ridge swings abruptly round to form the outer border of the paroccipital process, and the squamosal division of the bifurcation is not so strongly marked. *Dromas* therefore, in respect of the lambdoidal ridge and, indeed, of the whole occipital area, as well as the morphology of the squamosal region and the squamosal articulation of the quadrate, is very Larine.

Supra-occipital Foramina.—In *Dromas* these are absent, as they are in the Skuas, Gulls, Terns, Sheath-bills, and Stone-Plovers. In *Hæmatopus* they are present (or indicated) as they are in the Limicolæ generally.

Cranial Roof.—On a cursory examination, the cranial roof presents a very striking similarity to that of a Gull—the arrangement of the temporal fossæ being, for instance, almost precisely similar to what obtains in *Larus canus* (*cf.* text-figure 10 B). In *Dromas* these fossæ approach the mid-line even closer than they do in *Larus canus*, being separated by a space of 4 mm. only, whereas in *Larus canus* the intervening space measures 5 mm. In *Hæmatopus* the temporal grooves fall far short of the mid-line, the arrangement being more pluvialine. In the Stone-Plovers we note a transitional series ranging from a nearly pluvialine condition in *Œdicnemus* to a complete larine similarity in *Orthorhamphus magnirostris*.

In the Skuas, as I have previously pointed out ('Ibis,' 1916, p. 140) the arrangement of the temporal grooves is not at all larine, but is closely similar to what is seen in *Squatarola* or *Pluvialis*, although in *Megalestris* there is a considerable extension towards the mid-region.

Text-figure 10.



Dorsal view of the skulls of
A. *Dromas ardeola*; B. *Larus canus*.

In *Dromas* there is an indication of a sagittal groove down the centre of the fronto-parietal region, much as is seen in *Larus*; but the same condition is to be noted in *Charadrius* and *Hæmatopus*.

The most noticeable feature, however, of the cranial roof is the well-marked supraorbital depressions, which are remarkable for their resemblance to those of *Larus*. The depressions or grooves meet in the mid-line of the interorbital region, a thin sagittal ridge of bone alone separating them (*cf.* text-figure 10).

As in *Larus*, the floor of either groove is perforated towards the hinder margin of the orbital rim by small foramina or fenestra. In the Skuas and Sheath-bills there is a distinct break in the continuity of the curve of the outer edge of the orbital rims in this region, while the fenestra in the floor of the grooves are larger, so that in this respect the Skuas differ from either *Larus* or *Dromas*.

As compared with *Larus*, the interorbital space in *Dromas* is more elongated, but otherwise there are no essential differences, and we may even observe in the two forms a faithful reproduction of the curious ear-shaped processes of bone in which the orbital margins of either side terminate as they approach the postorbital processes. In the form and structural details of this interorbital region *Hæmatopus* is, of course, also notoriously larine—that is to say, it is similar in this respect to *Larus canus*.

Lacrymals.—Still proceeding forwards, we arrive at the lacrymals, and here, for the first time, we note any very obvious morphological differences between the skulls of *Dromas* and *Larus*.

In *Larus* the orbital portion of the lacrymal is produced outwards and backwards as a free and prominent process (*cf.* text-figure 10). In *Dromas* the orbital portion of the lacrymal has no such free process. On the contrary, it is at first directed abruptly outwards at right angles to the long axis of the skull, and then again makes a right-angled turn forwards and downwards, to be continued into the descending process of the lacrymal. In this respect *Dromas* is pluvialine.

As regards the descending process of the lacrymal in the two forms, there are certain noticeable differences. In both *Larus* and *Dromas* it is first continued downwards, forwards, and slightly inwards, and then is bent backwards so as to

make an angled knee ; but, whereas in *Dromas* this backwardly-directed or distal extremity has an inward direction, in *Larus* it has an outward. In *Dromas,* too, the angle made by the proximal and distal halves of the descending process of the lacrymal is much less acute than in *Larus,* and, as a consequence, the distal end approaches the antorbital plate from above, while in *Larus* it approaches the same structure from well in front (*cf.* text-figure 10). In both forms we find, projecting forwards from the angled knee, a spinous process ; but, whereas in *Dromas* it is thin, sharp, and conspicuous, in *Larus* it is aborted. In all the above-mentioned points the lacrymals of *Dromas* have a modified pluvialine arrangement in contradistinction to a typical larine. In *Hæmatopus* the descending process of the lacrymal makes no such angled knee as described above ; on the contrary, it comes down perpendicularly to fuse with the antorbital plate in the usual pluvialine method.

In both *Dromas* and *Larus* the distal end of the descending lacrymal fuses with the extero-superior angle of the antorbital plate of the mesethmoid or with its apex or outer extremity. In the freshly-hatched chick of *Dromas* it fuses with the extero-superior angle.

Fronto-nasal Region.—Corresponding with the differences in the lacrymals in the above forms, we find that there are other distinctions to be noted in the fronto-nasal region. Briefly noted, these are the shorter relative length of the fronto-nasal space in sagittal section in *Dromas* ; the contrast in the method of articulation of the proximal ends of the nasals (text-figure 10) ; the greater length of the nasal vacuity in *Larus* and its different shape.

In both *Larus* and *Dromas* we find a schizorhinal arrangement.

Premaxillæ.—In several respects the upper jaw of *Dromas* is not pluvialine in form. Neither is it larine. It is, however, very similar to the condition of things to be noted in œdicnemine genera. Its palatal surface (text-figure 11), distad of the point from whence its maxillary processes have an independent existence, forms a continuous,

though slightly hollowed bridge from one cutting-edge of the tomium to the other; and in this respect it agrees with all the Stone-Plover genera, but more especially with *Orthorhamphus*.

As in these œdicnemine genera, the palatal surfaces of the maxillary processes of the premaxillæ are flat, broad, and ribbon-like.

In the Charadriidæ, such as *Squatarola* and *Pluvialis*, the palatal surface of the premaxillæ is not bridged in the above fashion, with the result that a distinct groove is left between the tomial edges right up to the very tip of the bill. In the Gulls (Laridæ) and Skuas (Stercorariidæ) a modification of this bridge is seen which is quite distinctive, while in both the Sheath-bills (Chionididæ) and the Oyster-catchers a condition of the hard palate peculiar to either group is again seen.

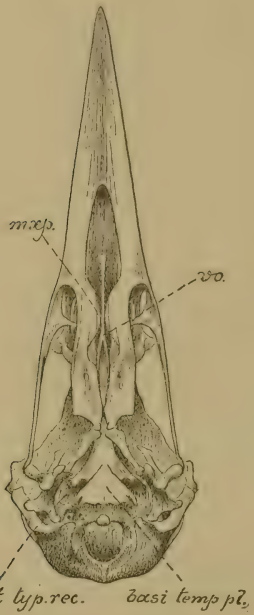
Taking a general view of the premaxillæ of *Dromas* and *Orthorhamphus* the resemblance in morphological details is very striking, but since *Orthorhamphus* is peculiar among the Stone-Plovers in leading a littoral existence, and indeed in making its nest on the actual shore, this resemblance does not warrant any deductions as to a like affinity, and may be ascribed solely to functional stress.

The Base of the Skull.—In *Dromas* there is a somewhat deep and distinctly defined cordiform pre-condylar fossa (text-figure 11). The basi-temporal plate is thin and equilateral, its surface being smooth and grooved in the sagittal axis, while its postero-external angles do not terminate in the downwardly projecting processes so characteristically seen in the Gulls and Terns.

In place of these we observe in *Dromas* a sharp spur-like or pointed process, directed outwards and backwards, a condition which is more perfectly seen in the Skuas and less perfectly in the Golden Plover. Curiously enough, the downwardly projecting processes so characteristic of the Laridæ are to be noticed in *Squatarola*, while they are present in some Stone-Plover genera (*Œdicnemus*) and absent in others (*Orthorhamphus*).

The osseous irregularities along the base of the basi-temporal plate are not, in *Dromas*, mammillated or conspicuous as they are in *Hæmatopus*—the condition noticed approaching that peculiar to the Skuas.

Text-figure 11.



Palatal view of the skull of *Dromas ardeola*.

ant.typ.rec., anterior tympanic recess; *basi temp.pl.*, basi-temporal plate; *mx.p.*, maxillo-palatine processes; *vo.*, vomer.

In *Dromas*, as well as in the Gulls, Terns, Skuas, Stone-Plovers, and Charadriidæ, the planes of the basi-occipital and basi-temporal are almost identical, but in the Oyster-catchers the two planes are inclined at a conspicuous angle.

In respect of the arrangement of the Eustachian tubes and the underlap of the apical portion of the basi-temporal plate, *Dromas* appears to be larine. Shufeldt says ('Emu,' vol. xv. 1915, p. 6) that in this respect *Orthorhamphus* is larine, and with this statement I agree, but other Stone-Plover genera such as *Œdicnemus* seem to present transitions from the pluvialine condition to the larine. Both the Sheathbills and *Hæmatopus* are in this respect pluvialine, but the condition seen in the former is peculiar.

The pterygoids in *Dromas* are somewhat short and pluvialine. They are compressed from side to side. Viewed from their basal aspect, they appear more ribbon-like than in *Larus*, in which genus (and other true larine genera) we get an impression of long, thin, and rounded rods. Even in the Laridæ, however, the pterygoids are compressed from side to side, and produced dorsally into a thin-edged border. In the Skuas the pterygoids are almost strictly rod-like structures, viewed from every aspect, but they are shorter than in the true Gulls. Although the skulls of *Larus canus* and *Dromas ardeola* are almost exactly the same length, and have the same general proportions, yet the length of the pterygoids in *Larus* are 13·5 mm. as compared to 11 mm. in *Dromas*.

In the adult *Dromas* there is no hint of any articulation between the pterygoid and the basisphenoidal rostrum (no basipterygoid processes). In *Hæmatopus* the pterygoids are very short, actually nearly as short as in the Golden Plover. Basipterygoid processes are present, and the whole picture is typically pluvialine. In the Stone-Plovers the pterygoids are neither typically pluvialine, larine, nor stercorarine. They may be said to be œdicnemine. In regard to their length, however, the pterygoids of *Orthorhamphus* approach a larine condition. Shufeldt (*l. c.*) says that "the pterygoids of *Orthorhamphus* and *Œdicnemus* are much more like these bones in Gulls, in *Chionis*, and others, than they are in birds belonging to the typical Charadriinæ."

Palatal Region.—The palatal structures of *Dromas* come closer to those of œdicnemine genera than any other

Charadriiform groups with which we have compared them; but of these genera they are closest to *Orthorhamphus*. The resemblance to *Orthorhamphus* is remarkable, but is probably an instance of parallelism, or due to similar functional stresses. The resemblance of the interpalatine laminæ and the prepalatine processes with their continuation forwards into the palatal processes of the premaxillæ is to be specially noted.

In *Dromas* the identity of the palatal surfaces of the maxillo-palatines is almost lost on the prepalatine bars, owing to their narrowness and to their nearly complete fusion with these structures. In *Orthorhamphus* the fusion is not so complete, but, nevertheless, the maxillo-palatines of this genus come very close to those of *Dromas*. In *Hæmatopus* we seem, as regards the morphology of the palatal plates, palatal bars, the complete fusion of the maxillo-palatines, and their diminished size, to have gone a stage further than *Dromas*.

Reverting to the maxillo-palatines, these in *Dromas* present on their external aspect and towards their hinder half a slipper-like sac, with its toe directed proximally. The maxillary sends a triangular process directly inwards to join the maxillo-palatine at the point of entrance to this slipper-like sac. In *Chionarchus* I have noticed exactly the same condition of things. In *Orthorhamphus* the maxillary sends a like process inwards to fuse with the outer edge of the scroll-like palatal surface of the maxillo-palatines. In *Hæmatopus* a modified or very specialised arrangement is seen. In this last genus it is curious to notice that the hinder border of the maxillo-palatines completely fuses with the ethmoidal portion of the palatal plate, so that there is absolutely no break whatever between the two.

In *Larus* and *Rissa* the palatal surfaces of the maxillo-palatines are quite free, except at their distal extremity (*cf.* 'Ibis,' 1916, p. 146, text-figure 4), and here the maxillary joins them. As a consequence, we get no fenestrum distad of this process in the Laridæ, as we do in the Skuas, Stone-Plovers, Oyster-catchers, Sheath-bills, Crab-Plovers, and pluvialine forms generally. The difference in

this respect between *Larus* and *Stercorarius* is noteworthy, and I have already called attention to it in 'The Ibis' (*l. c.*).

Quadrate.—In all the groups that have been discussed, including *Dromas*, the quadrate has its own peculiar and distinctive characteristics. The orbital process of the quadrate in *Dromas* is very similar to that of *Stercorarius*. The quadrates of *Hæmatopus* and *Chionis* both agree in being relatively and actually longer than in either of these last-mentioned genera. In *Dromas* there is a foramen, leading into a pneumatic chamber, on the inner surface of the body of the quadrate. In *Larus* it is noticed on the posterior surface. In the Skuas there is also a foramen on the inner surface, but it is placed lower down than in *Dromas*, just above the quadrato-pterygoid articulation. Such precise and apparently meaningless, and probably useless, distinctions in regard to a small point such as this, compels the thought that such differentiations could hardly have been brought about through the process of continuous variations. The constancy of the precise position of these quadratal foramina in a series of skulls of any groups selected, *e. g.* the Gulls or the Skuas, is very remarkable, no matter what genera are taken in either group.

Antorbital Plate.—In *Dromas* this is a strongly ossified, triangular or ear-shaped process. So it is in *Larus*; but in *Dromas* the descending process of the lacrymal approaches this extension of the pre-ethmoid at a different angle (see under "Lacrymal").

Turbinals.—In *Dromas* a prominent bridge of bone proceeds from the superior border of the antorbital plate, to fuse with the outer rim of the external and superior border of the pre-ethmoid. It is continued forwards as a thin turbinal plate, which is ossified. A very similar arrangement is seen in *Larus* and *Stercorarius*. Mesiad of the above-mentioned bridge is seen a foramen for the olfactory nerve.

Interorbital Septum.—The fenestra in *Dromas* are somewhat peculiar, but, on the whole, are reminiscent of what obtains in *Squatarola*, except that the lower and largest fenestrum is quadrangular.

Vomer.—This bone sits astride of the parasphenoidal rostrum, as in *Larus* or pluvialine Waders. It is continued forwards well beyond the maxillo-palatine processes as a thin spiculate process, apparently slightly truncated at its extremity.

Other Osteological Characters.

Vertebral Column.—In *Dromas* there are 15 cervical vertebræ, which may be subdivided into—cervicals proper 12, cervico-dorsals 3.

The three cervico-dorsal vertebræ have hypapophyses which are peculiar to them alone. The first two dorsal vertebræ have hypapophyses which are thin, laterally compressed triangular plates, with the apex directed downwards and forwards. The apices are bifid.

The last two cervical vertebræ proper (11th and 12th) have their hypapophyses distinctively shaped. They are thin, laterally compressed, plate-like processes with truncated free ends directed forwards and upwards. The hypapophysis of the 10th cervical vertebra is bifid. The three cervico-dorsals carry floating ribs, the first pair being very short. The last cervical vertebra proper has a costal process, which is fused with the centrum. *Hæmatopus*, it may be noted, also has three cervico-dorsal vertebræ, and, as in *Dromas*, on each of these three vertebræ the articulation for the capitellar head of the free rib is quite obvious and distinct.

In *Hæmatopus* the 2nd and 3rd dorsal vertebræ have hypapophyses which are very similar to those seen in *Dromas*. The hypapophysis of the first dorsal vertebra is like that of the last true cervical in *Dromas*.

In *Charadrius pluvialis* there are three cervico-dorsal vertebræ, as also obtains in *Ægialitis hiaticola*. Curiously enough, *Squatarola* has only two.

I have also noted that there are only two cervico-dorsal vertebræ in the following Charadriiform genera:—*Vanellus*, *Lobivanellus*, *Chionis*, *Chionarchus*, *Œdicnemus* (and perhaps other œdicnemine genera), and *Arenaria*.

In the Sheath-bills the 1st and 2nd dorsals have hypapophyses which are very similar in appearance to those of

Dromas, but that of the first is triradiate instead of bifid at its extremity. The hypapophyses of the cervico-dorsals are also very similar to, if not identical with, those of *Dromas*.

Sternum.—This is long and laterally compressed, and in general features is more pluvialine than larine.

Humerus.—Taking this bone as an index of the whole upper limb, I find that the characters exhibited by it are distinctly pluvialine. It is easily to be distinguished from either a larine, sternine, or stercorarine humerus.

Lower Limb.—There are no points about the bones of the lower limb worthy of special notice here. It seems sufficient to note that they present pluvialine characters.

Skull of a Chick.

The most interesting feature about the skull of the nestling Crab-Plover sent to me by Dr. Brockman was the fact that basipterygoid processes were present. As might have been expected, these were not so perfect as was the case in the young *embryo* Sheath-bill referred to above (*cf.* text-figure 7), since this young Crab-Plover had evidently been hatched for several days; but, nevertheless, both the facets on the pterygoids and the corresponding processes on the basisphenoidal rostrum are very clearly to be seen in the specimen which I have preserved and which is now in the British Museum collection. Moreover, on the left side a distinct and tough ligamentous band is to be noted joining the basisphenoidal process to the pterygoidal.

As regards the rest of the skull, very little more can be learnt from it than from an adult skull, except that the supraorbital portion of the vault of the cranium has a more generalised and has a more true limicoline facies than is the case in the adult skull. We might, indeed, go further, and state that this anterior frontal, as well as the lacrymo-nasal region, is reminiscent of a tringine (totanine *olim*) Wader, so narrow is the interorbital space and so little specialised and simple are the supraorbital margins and grooves. Supra-occipital fenestra are not present or indicated.

A comparison of the skull of this young Crab-Plover with the skull of a newly-hatched Tern seems to suggest no close affinity, in the sense that the Crab-Plover would be called a Tern. In the quite young nestling Tern examined (two or three days old) the arrangement and development of the maxillo-palatines, maxillaries, and palatines was almost an exact reproduction of what obtains in the adult Tern, the maxillo-palatine processes being especially well developed, conspicuously advanced in ossification, and entirely free from any fusion with the palatal bars. In this Tern chick the relics of basipterygoid articulations were distinctly evident. No supraoccipital fenestra were indicated. The antorbital plates were cartilaginous. The interorbital region (pre-frontal and frontal) had a distinctly more generalised (true limicoline) facies than obtains in the adult Tern, and, indeed, the general configuration and the absence of specialization in regard to the whole of the upper portion of the skull and premaxilla was very reminiscent of the Turnstone.

It seems hardly necessary to add that until a series of actual embryos of the Crab-Plover and Tern are available for the purpose of comparison, we are not likely to get much further towards probing the secrets of their phylogeny ; but we have tried to make the best of the material at our disposal

Summary.

The above review of some of the principal features in the osteology of *Dromas* seems to fully justify the opinion that this peculiar type of Wader deserves a special niche of its own in the classification of the Chadriiformes, and that its affinities with the Gulls, Terns, Stone-Plovers, or other aberrant groups are no closer than is implied in the conception that all such groups have a common ordinal or subordinal fellowship. Using the term "Plover" to embrace any Wader comprised in the true Limicolæ (Charadriidæ—Scolopacidæ), *Dromas* is undoubtedly a specialised Plover, just as a Gull is a specialised Plover ; but any Gull-like,

Tern-like, or Stone-Plover-like characters which it may possess are superficial characters which appear to have been moulded upon it either through the plastic influences of similar environments and similar functional stresses, or in virtue of descent from a common ancestral type.

From what one has gleaned from an examination of the skull of the nestling Crab-Plover and of the young Tern, we feel drawn to the conclusion that an examination of embryos of these and other allied aberrant forms would point to the fact that all the Laro-Limicolæ (Gulls, Terns, Skuas, Pratincoles, Sheath-bills, Crab-Plovers, and perhaps Oyster-catchers) sprang from the main Charadriiform stem prior to the division of that stem into its charadriine and scolopacine branches. Furthermore, that the scolopacine branch represents the more direct continuation of the ancestral Charadriiform stem and that the true Plovers (Charadriidæ) represent a specialised offshoot from this scolopacine continuation or from the true limicoline stem.

We shall hope in a future paper to make our meaning clearer by means of a diagram, representing the phylogenetic relationships of the whole order Charadriiformes.

XVI.—*The Denudation of the Shaft in the Motmot's Tail.*

By Hubert D. Astley, M.A., F.Z.S., M.B.O.U.

The keeping of living birds in captivity will in many cases very much assist collectors of bird-skins and investigators in museums to solve certain moot points ; because the moults can be studied, and not infrequently the nestling plumage made known, when successful breeding comes about in an aviary. Hence it is that aviculture of late years has become a hand-maid to what is understood as scientific ornithology—an extra horse to go as a tandem and accelerate the pace.

And aviculture not only helps with regard to the study of the birds, but also in respect to their nidification, habits, and eggs, for the latter may be laid in captivity when they have never been found in the wild state, and, furthermore,